Foundation models for agricultural sciences Challenges and opportunities

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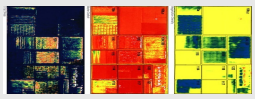
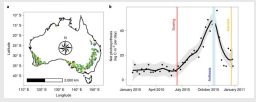
AI successes in agriculture

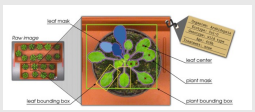
Precision agriculture and livestock farming (2000)



Continent-wide field trial monitoring (2021)



Computer vision for plant phenotyping (2014-)



Reinforcement learning for crop management (2022)

The Agricultural AI efficacy gap

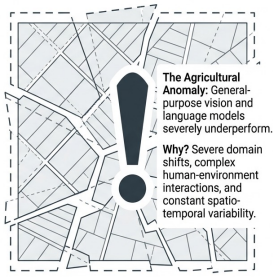
Reality:
Agricultural AI routinely fails to generalize across space, time, species and production systems

Environment
- Landscape
- Climate
- Remote Sensing
- Weather
- Soil

Management
- Agricultural practices
- Crop calendar
- Historical yields

Genetics
- Cultivars
- Phenotypes
- Genotypes

Global scale | Farm scale | Field/Plot scale

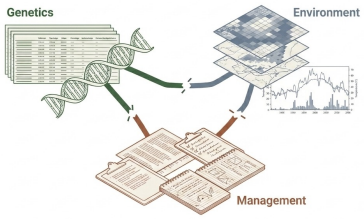


Biology x Nature x People

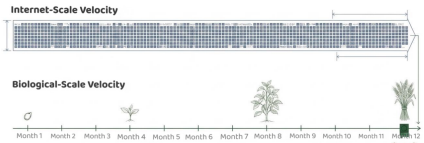
Challenges

- Complex Genetics-Environment-Management interactions
- Limited, fragmented data in misaligned corpora
- Siloed knowledge across several disciplines

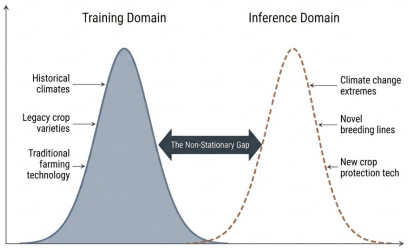
Disconected data modalities



One label per year bottleneck



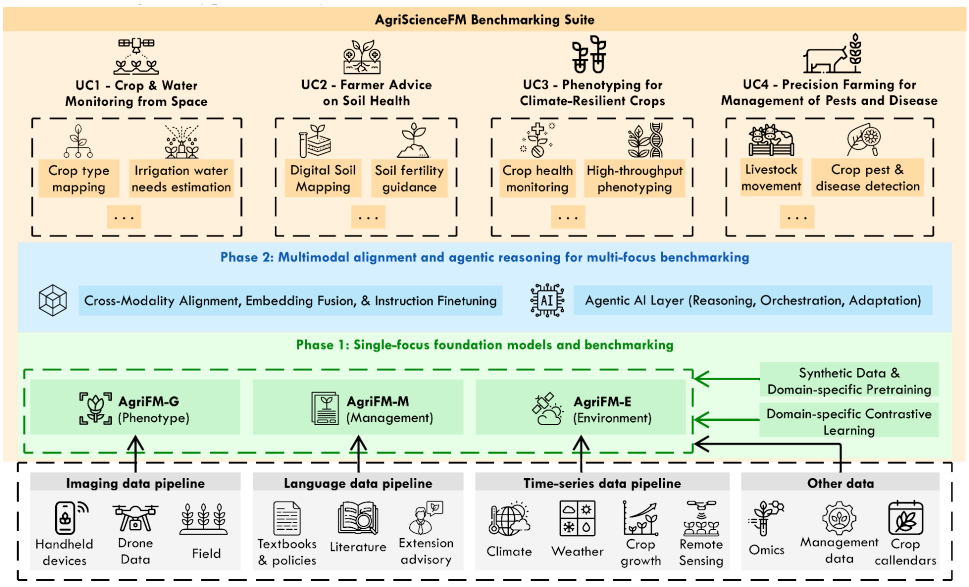
Unavoidable Domain Shifts



An architectural pivot is necessary

	Task-specific deep learning models	Opportunities for agricultural foundation models
Data requirements	Require massive, aligned labelled datasets	Leverage small multi-modal unpaired corpora via SSL
Knowledge representation	Learn observational correlations	Regularize with implicit knowledge and fundamental principles
Adaptability	Overfits to local effects – retraining per location or task	AgriFMs act as jumpboards for robust few-shot learning

The AgriScience.FM Project 2026-2029



Thanks to our team!

WAGENINGEN UNIVERSITY & RESEARCH, UNIVERSITÄT BONN, vito, CERTH, CVC Computer Vision Center, Inria, novelcore, ILVO Flanders Research Institute for Agriculture, Fisheries and Food, Barcelona Supercomputing Center, University of Nottingham, McGill

Prerequisite for progress: domain-specific benchmarks!

Standardized Data
Establish training-test splits to address domain specific bias and reflect relevant generalization regimes (new locations, climate, crops)

Rigorous Metrics
Evaluate downstream task accuracy alongside the intrinsic quality of agriculture-specific embeddings

Dual Baselines
Compare models against BOTH state-of-the-art agricultural methods AND general-purpose AI methods

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